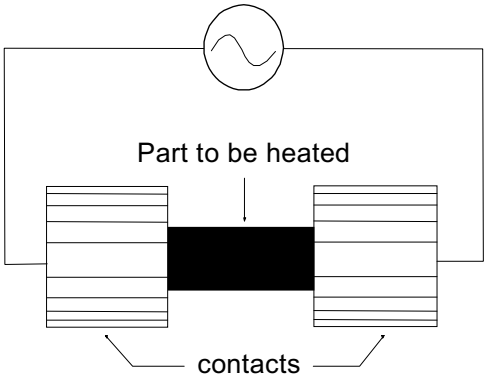
Applied Technology: Direct Resistance



Source: EPRI TechCommentary V2, N8, 1986

Concept

Direct Resistance heating involves passing an alternating current directly through the workpiece to be heated. Since the part must be electrically conductive, it is often also referred to as conduction heating. With this type of heating, clamp or roll types of electrodes must be used to physically make contact with the workpiece. For food products, the sauce or gravy is the workpiece. The resistance (R) of the workpiece to the current (I) passing through generates the I^2R heating. Low frequency current (60 Hz) heats the part throughout. High frequency current (400 kHz) tends to heat only the surface of the part.

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Applications

- Hot Metal Working; forging, stamping, extrusion, rolling, and upsetting
- Heat Treating
- Metal Joining; spot, seam, and flash welding
- Preheated Glass and Semiconductor
- Food Sterilization (Ohmic Heating)

Technologies Replaced

- Salt/Lead Bath Heat Treating
- Fossil/Electric (indirect resistance) Furnace
- Retort Canning of Food
- Flame Hardening
- Torch Welding

Wastes Reduced

- Combustion Pollutants; ROG, SO_X, NO_X,CO_X, Particulate
- Material Oxidation; slag, scale
- Salt/Lead Bath; hazardous salts/metals
- Process and Waste Water (Ohmic Heating)

Potential in Manufacturing

Indust	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*
Food	20	MED	Lumber	24	LOW	Chem	28	LOW	Stone	32	MED	Elect	36	MED
Tobac	21	LOW	Furn	25	MED	Petrol	29	LOW	**Pmetal**	**33**	**HI**	Transp	37	MED
Textile	22	LOW	Paper	26	LOW	Rubber	30	LOW	**MetFab**	**34**	**HI**	Instr	38	MED
Apparel	23	LOW	Printing	27	LOW	Leather	31	LOW	Mach	35	MED	Misc	39	MED

Credits: George Bobart, Bobart Associates; Unimar Group, Ltd; The Electrification Council; Electric Power Research Institute

Direct Resistance ***continued***

Technology Advantages

- Fast Heating
- Selective and Uniform Heating
- Small Space Requirements
- Moderate Cost
- High Efficiency

Technology Disadvantages

- Heating; uniform part cross-section required
- Heating; part must be long and slender
- Heating; low to moderate production rates
- Welding; part configuration must provide high resistance to flow of current
- Contact Surfaces; must be clean for good electrical connection

Typical Costs

Capital Costs	O & M Costs	Potential Payback
moderate: $25k - $100K	low maintenance, costs highly dependent on electric rates	1 - 2 years

Installations

Case A - An open flame oxy-fuel type of heat treat equipment was originally utilized by a midwestern machine tool manufacturer to selectively harden the teeth on a long gear rack. Using the flame process, there were basic problems with part distortion and uniformity of the hardening pattern. Due to the extremely low heating efficiency, the flame process also had high energy costs and air pollutants (combustion by-products). All of the process problems were corrected by installing a direct resistance heating system with direct contacts on each end of the hardened area. This greatly improved the quality of the part, reduced the energy cost by 70%, and eliminated all of the air pollutants.

Case B - Most of the tube and pipe around the world was produced by a process that utilized a fossil furnace to heat flat strip, form it into pipe and weld it along the length with an oxy-fuel torch. A newer type of high frequency direct resistance heating only heats a narrow area of the edge of the pipe that is to be welded. It therefore significantly reduces the energy required and the air pollutants associated with the older fossil fuel based welding processes. It is also much faster than certain conventional rotating electrode or the arc welding technologies, such as TIG or MIG processes. In addition, it provides far greater control of the seam temperature for the welding process, thus reducing product scrap due to rejects. While induction heating is often used for small diameter pipe and tube, direct resistance RF contact welding is extremely cost effective on larger diameter pipe, and generally provides a payback of less than 1 year.

Major Vendors

Direct Resistance

APV Crepaco*
395 Fillmore Avenue
Tonawanda, NY 14150
(716) 744-2336

IHS-Inductoheat
5009 Rondo Drive
Fort Worth, TX 76106
(800) 486-5577

Newcor Bay
1846 Trumbell Drive
Bay City, MI 48707
(517) 893-9509

Seco/Warwick
180 Mercer St
Meadville, PA 16335
(814) 724-1400

Taylor-Winfield
P.O. Box 500
Brookfield, OH 44403-0500
(216) 448-4464

Thermatool
31 Commerce St
East Haven, CT 06512
(203) 468-4100

* For Ohmic Heating (Food)

This list of vendors of the indicated technology is not meant to be a complete or comprehensive listing. Mention of any product, process, service, or vendor in this publication is solely for educational purposes and should not be regarded as an endorsement by the authors or publishers.

Index to EPRI DOCUMENTS

Direct Resistance Heating

Direct & Encased Resistance Heating, EPRI CMF TechCommentary, Vol 3, No 8, 1986

Direct Resistance Heating Blanks For Forging, EPRI CMF TechApplication, Vol 1, No 19, 1987

High-Frequency Resistance Welding of Tube, EPRI CMF TechApplication, Vol 1, No 15, 1987

Electric Arc Furnace Steelmaking ... The Energy Efficient Way to Melt Steel, EPRI CMF TechCommentary, Vol 1, No 3, 1985

Understanding Electric Arc Furnace Operations for Steel Production, EPRI CMP TechCommentary, Vol 3, No 2, 1987

Direct Current Electric Arc Furnaces, EPRI CMP TechCommentary, CMP-063, 1991

Static Var Control for Electric Arc Furnaces, EPRI CMP TechApplication, CMP-100, 1995

Special Publications

Parrott, Dr. David L.; *Use of Ohmic Heating for Aseptic Processing of Food Particulates*; Food Technology, December 1992, pp 68-72

This information is designed to help you determine **potential** applications for the technology. You are encouraged to contact one of the listed vendors or a consultant for details and pricing.

This manual is not intended as a recommendation of any particular technology, process, or method. Mention of trade names, vendors, or commercial products do not constitute endorsement or recommendation for use. It is offered for educational and informational purposes and is advisory only.

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